By Express Mail
No. EV 528956700 US

(12) UK Patent Application (19) GB (11) 2 338 009 (13) A

(43) Date of A Publication 08.12.1999

(21) Application No 9912369.7

(22) Date of Filing 28.05.1999

(30) Priority Data
(31) 9812039 (32) 04.06.1998 (33) GB
(31) 9812490 (32) 11.06.1998

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(51) INT CL^6
E21B 17/00 7/20 // E21B 33/04 43/10

(52) UK CL (Edition Q)
E1F FAC6 FAC9 FCM

(56) Documents Cited
GB 2311314 A EP 0241354 A WO 94/12760 A
WO 91/10805 A WO 90/00216 A

(58) Field of Search
UK CL (Edition Q) E1F FAC FCJ FCM FJR
INT CL^6 E21B
ON-LINE: EPODOC

(54) Abstract Title
Method for installing a well casing section

(57) The invention relates to a method of installing a casing section 15 in a well, by means of first and second connection means arranged on a tubular lowering means 26, the first connection means 94 being connected at an upper end of the casing section 15 and the second connection means being connected at a lower end of the casing section 15, the tubular lowering means 26 extending through the casing section 15. Flow paths are provided in the connection means to enable fluids from the well to pass through the inside of the casing 15, as the casing 15 is lowered into the well. A lockable non return valve 36 is provided at the lower end of the tubular lowering means 26 which permits the well fluids to flow from inside the internal bore of the tubular lowering means 26 to the well outside the section 15 being installed, and also permitting fluids to flow from the well to the inside of the tubular lowering means 26 and thus back to surface. When the casing 15 to be fitted has been lowered to its installed position the lockable return valve 36 is unlocked by means of an activating ball, thus operating as a conventional non-return valve and preventing the unwanted flow of fluids up the internal bore of the section 15 being installed. Alternatively, a drill arrangement 160 may be provided on the end of the lowering tube 126. Spring biased securing means 163 are provided which are activated to extend into corresponding locating openings 165 in the casing.

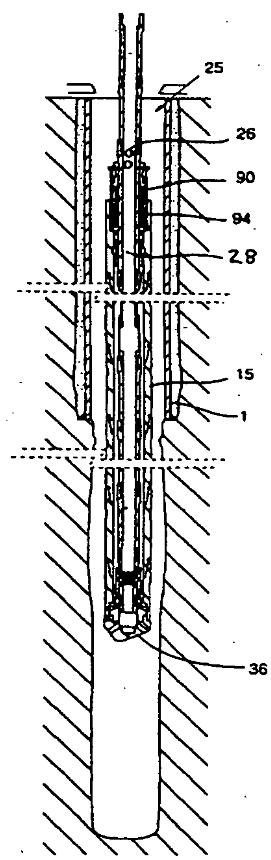

Figure 5

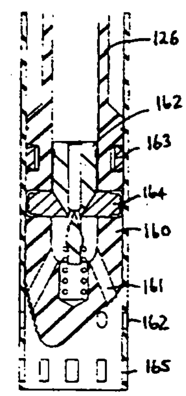

Fig. 19

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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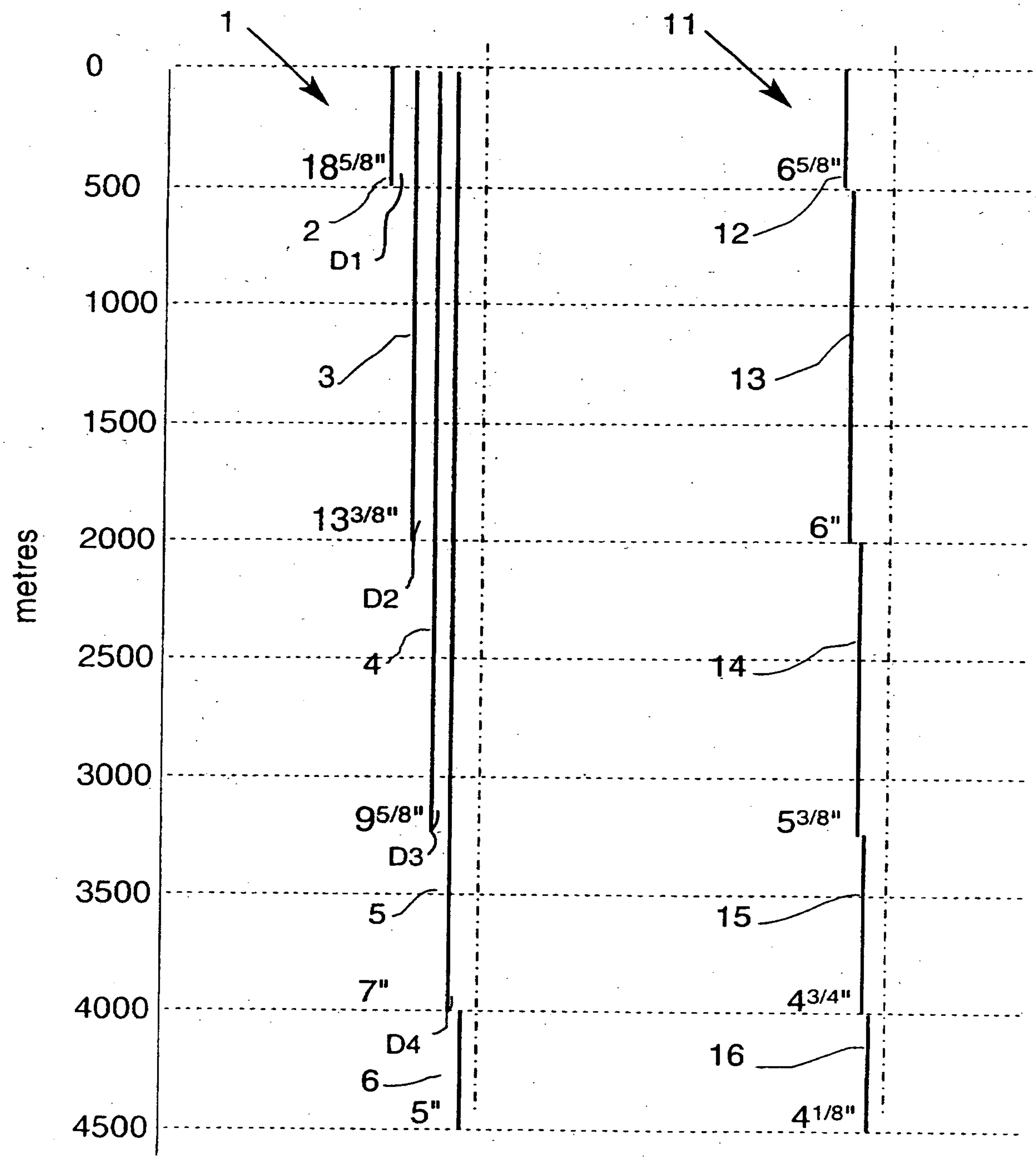


Figure 1

Figure 2

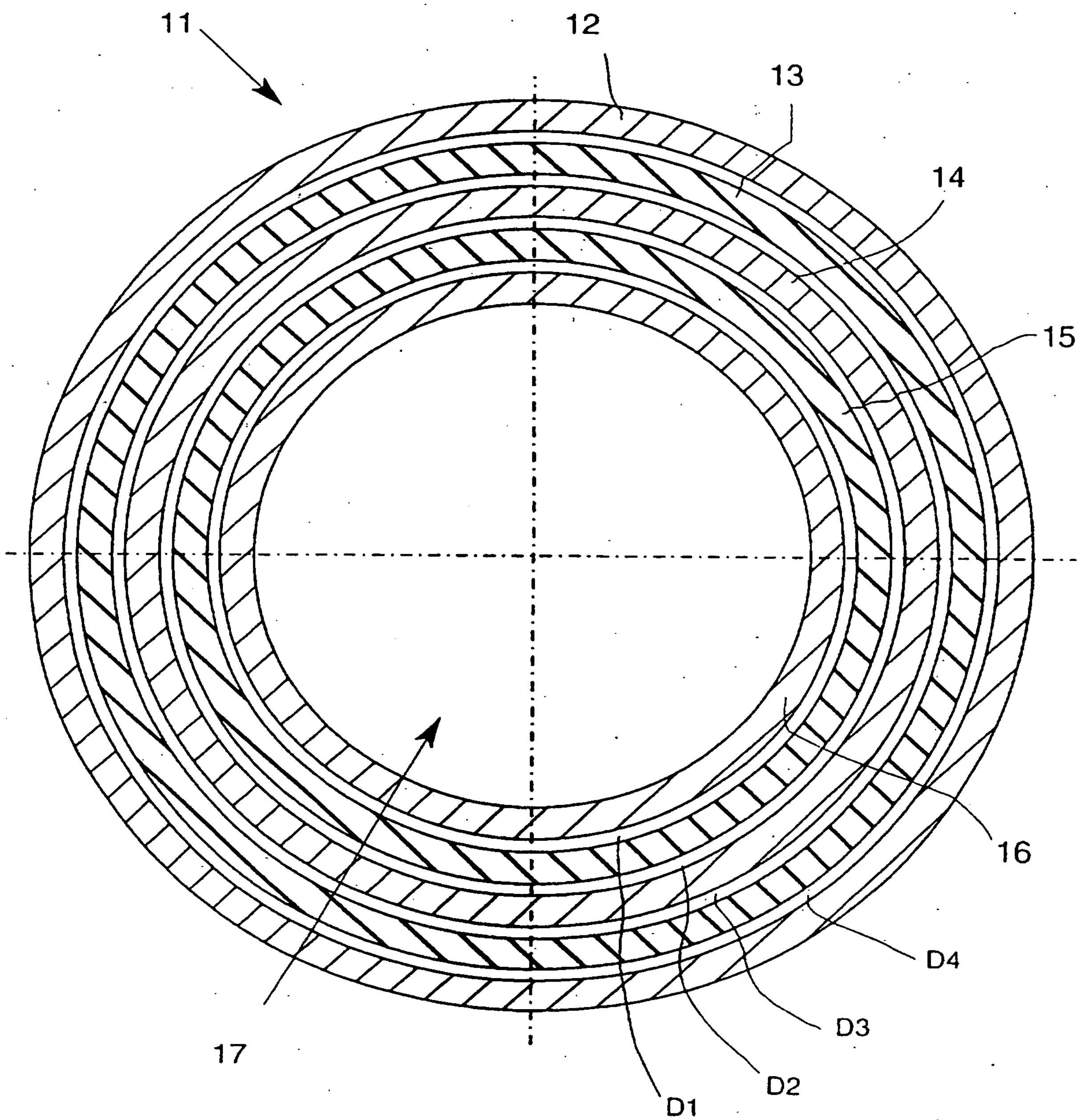


Figure 3

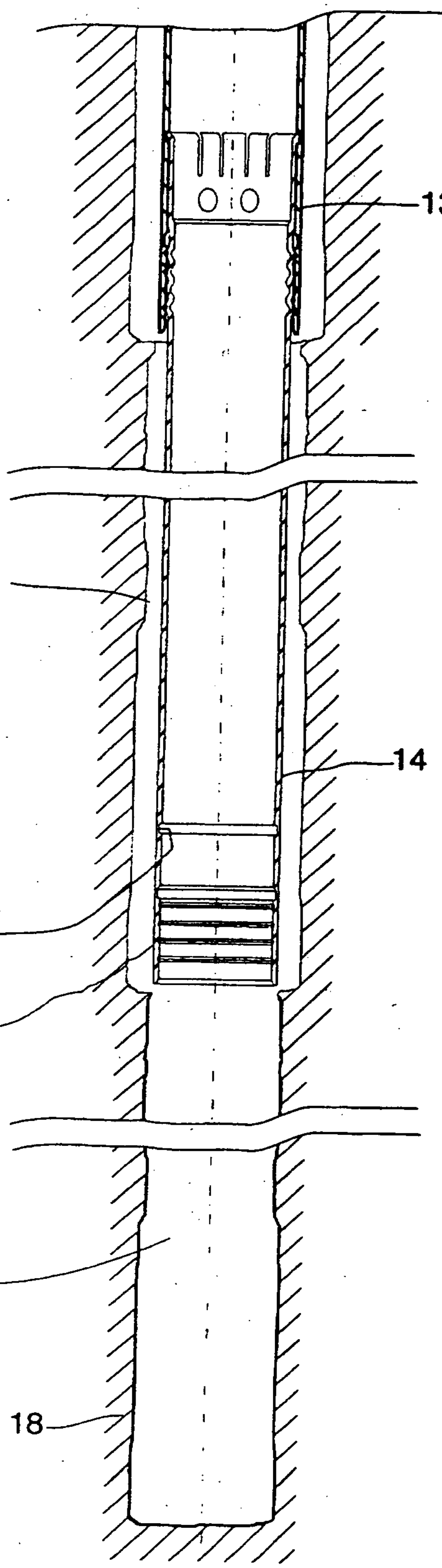


Figure 4

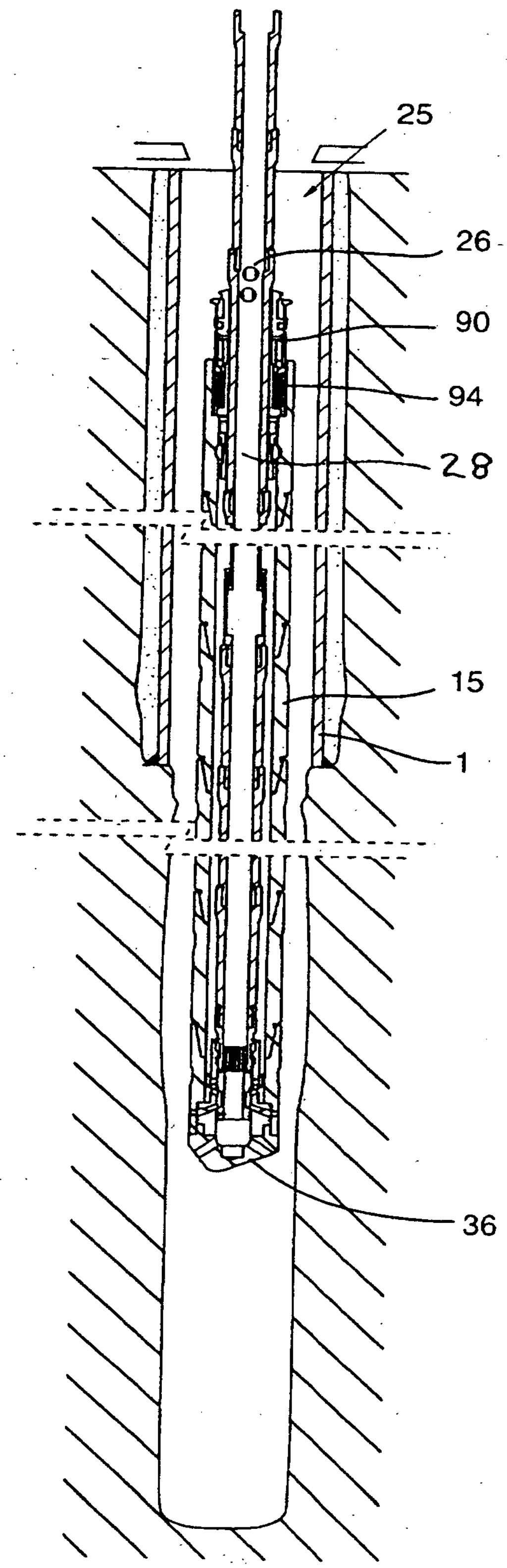


Figure 5

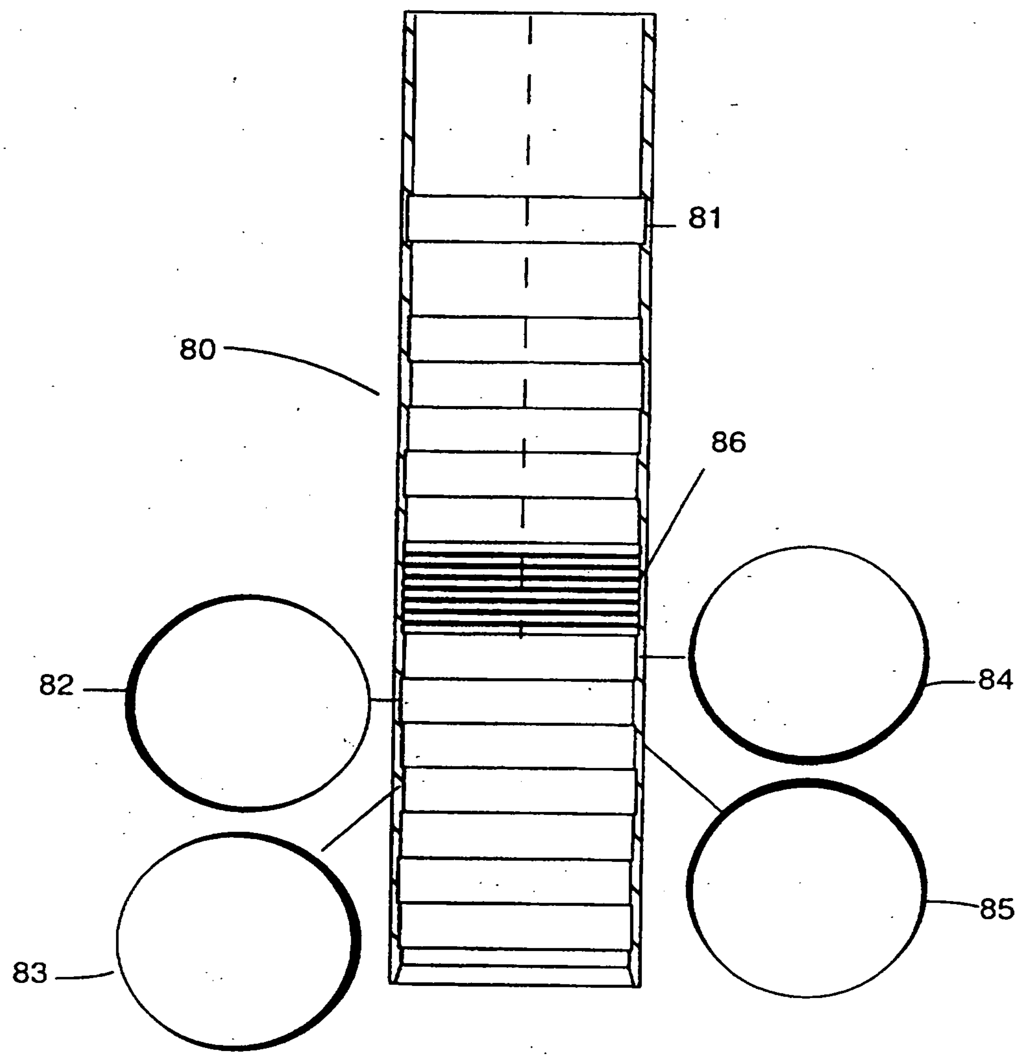


Figure 6

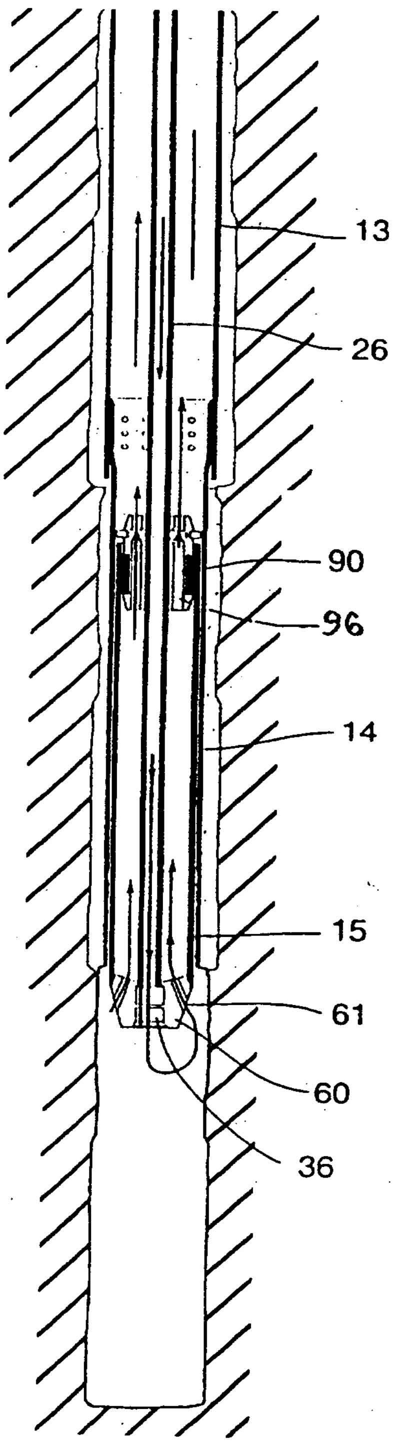


Fig. 7

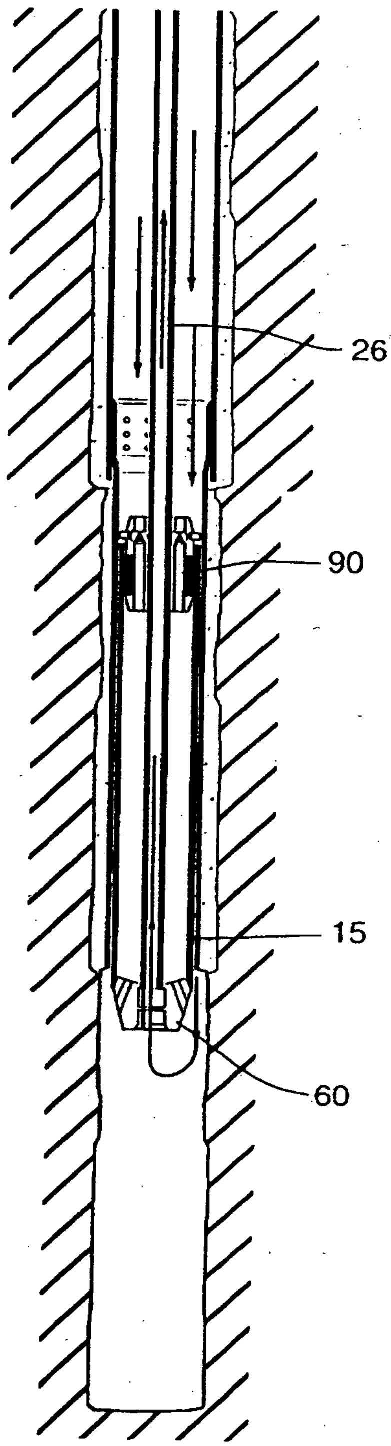


Fig. 8

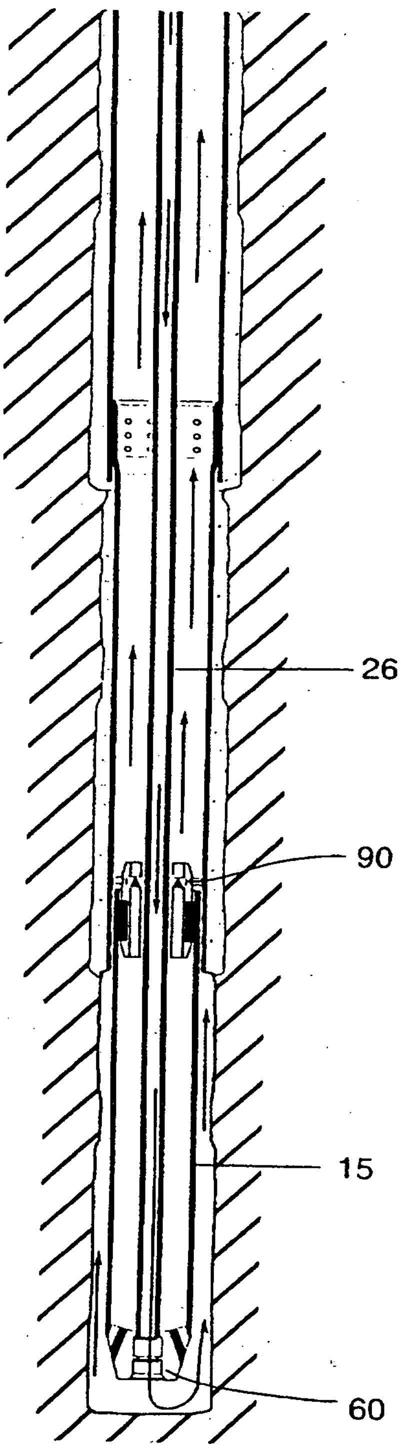


Fig. 9

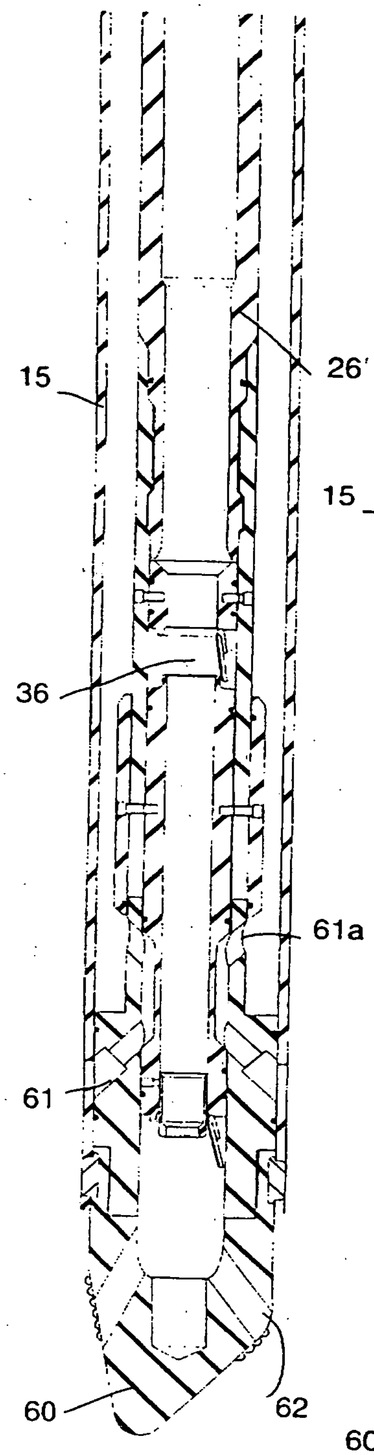


Fig. 10

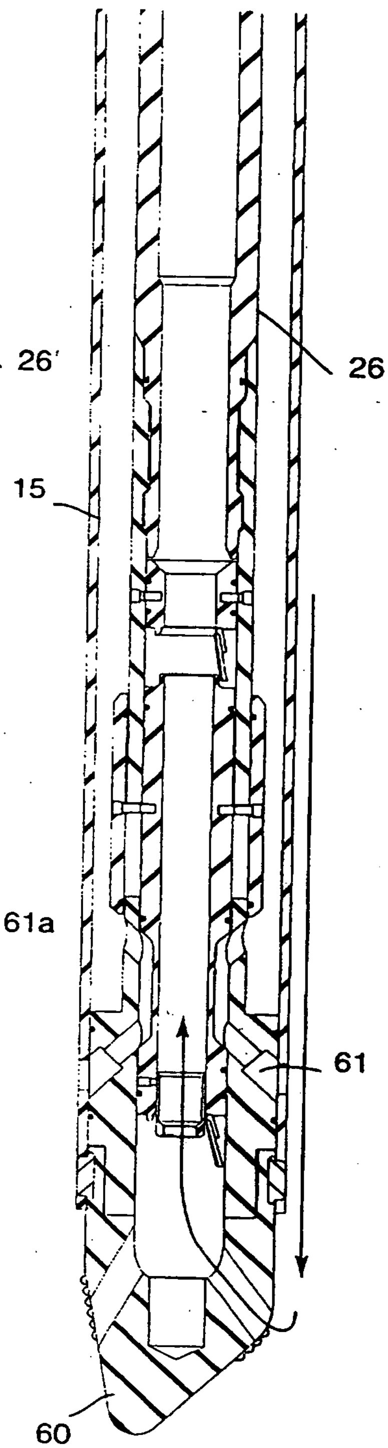


Fig. 11

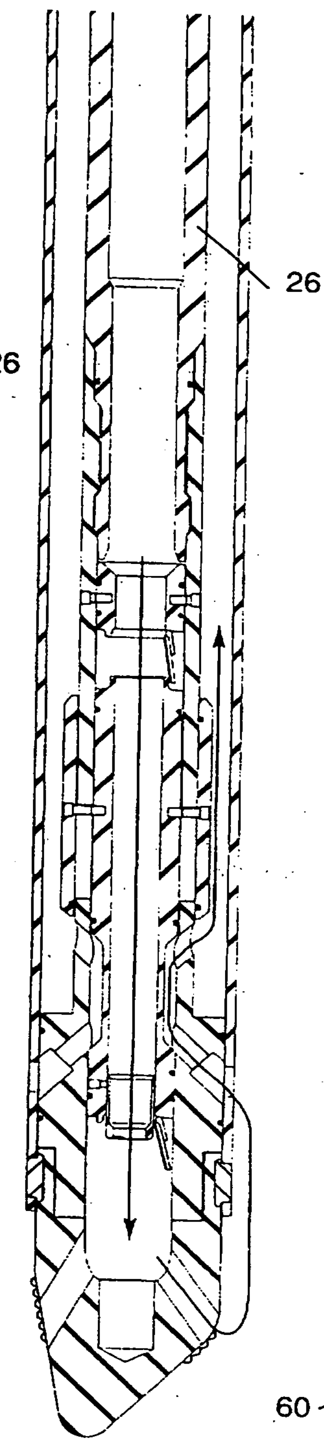


Fig. 12

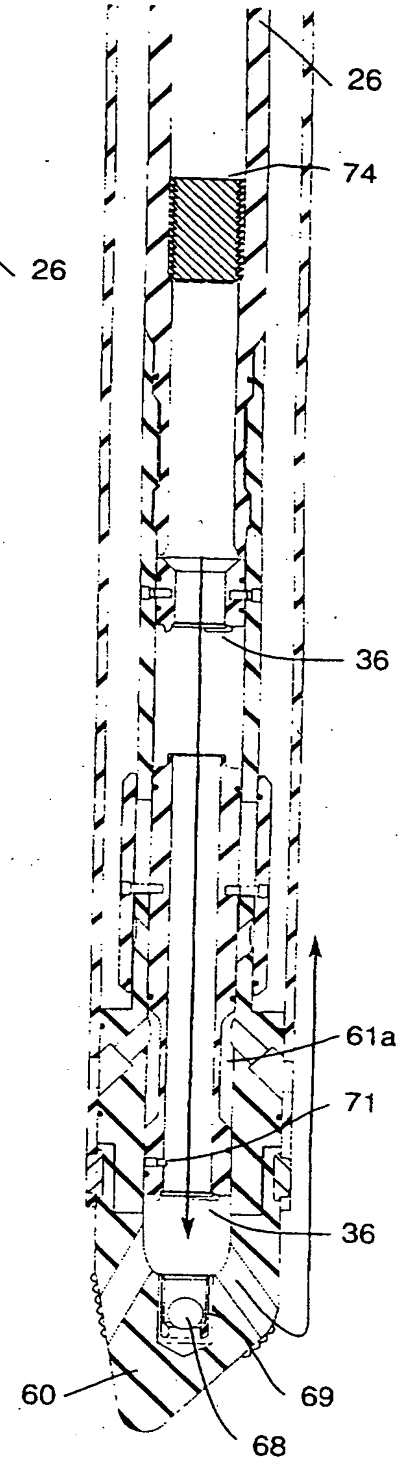


Fig. 13

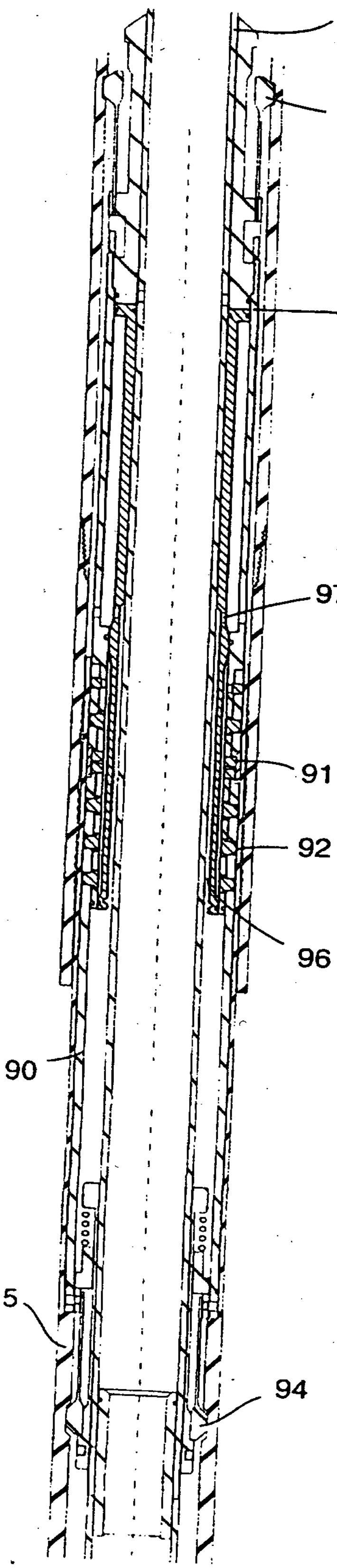


Fig. 14

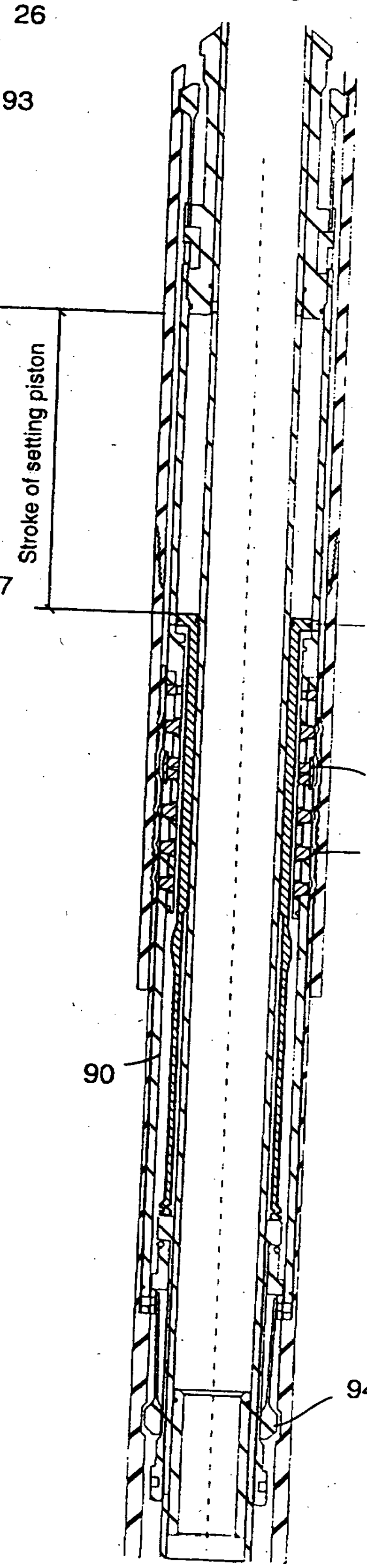


Fig. 15

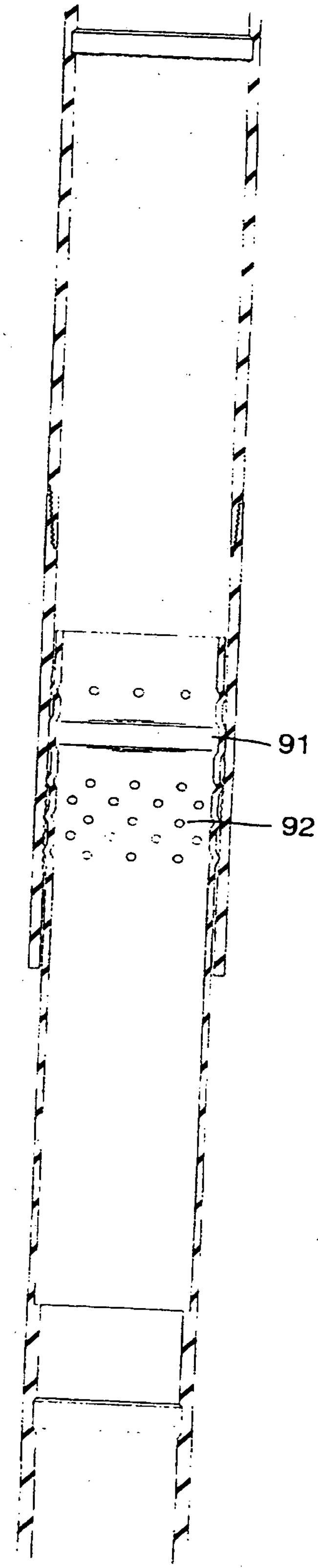
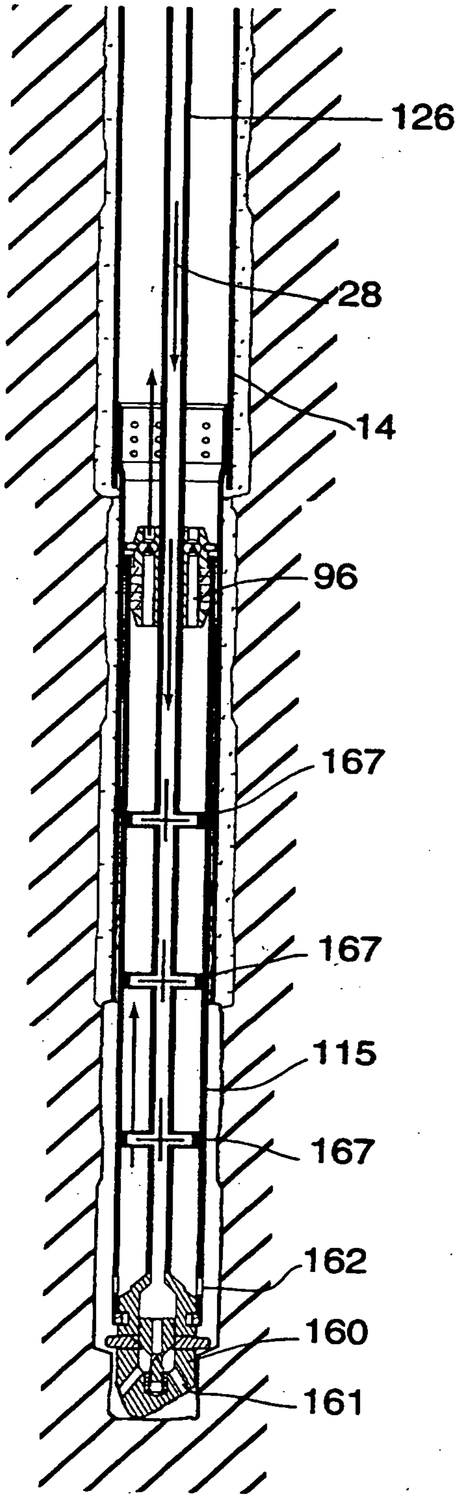


Fig. 16


126
28
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96
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167
115
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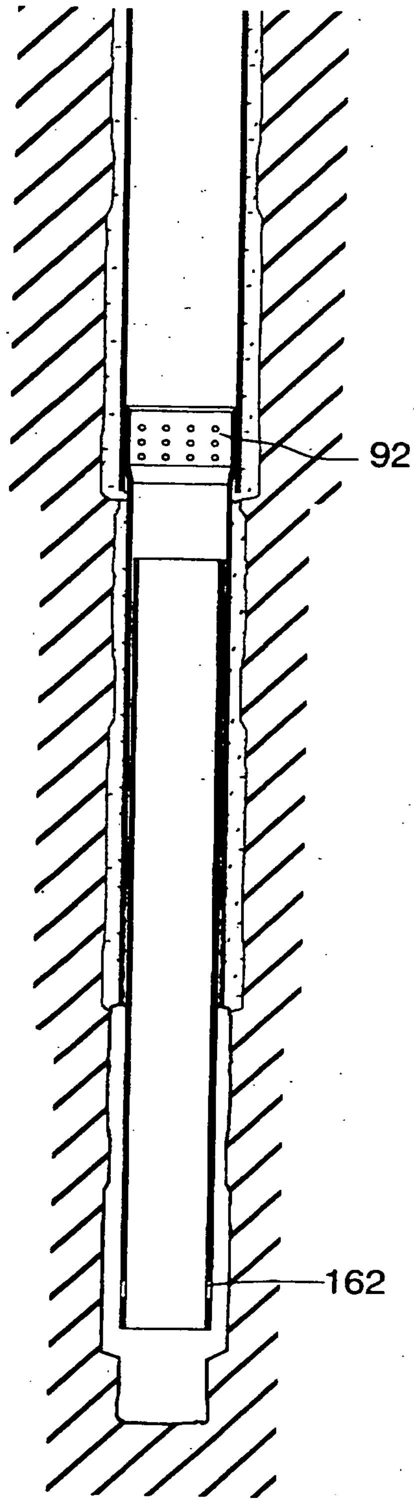
160
161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162

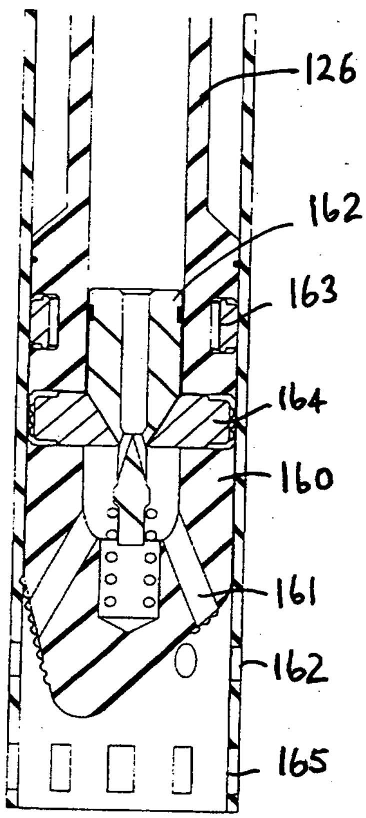

Fig. 19

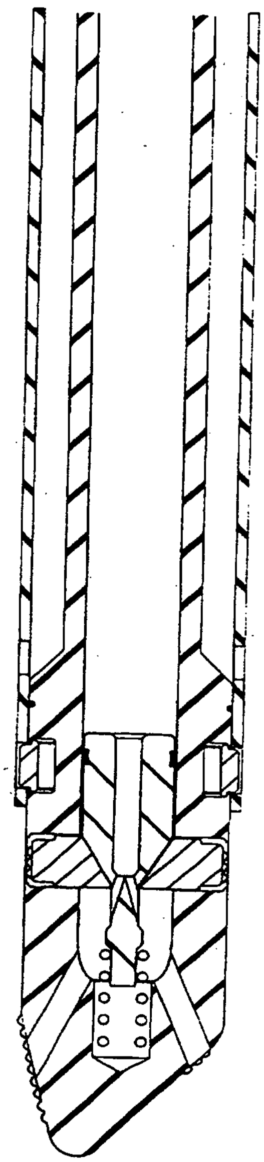

Fig. 20

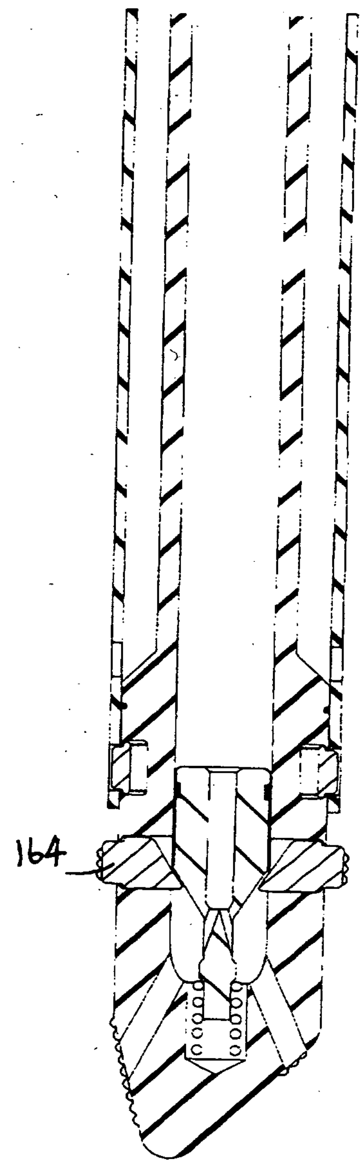

Fig. 21

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A Method of Installing the Casing in a Well and Apparatus therefor

The invention relates to a method of installing the casing in a well and apparatus therefore. Casings are required in wells in order to separate the well from the surrounding formations. Typically the casing is provided in sections which are lowered into the well following the drilling of each corresponding section of the well.

Each casing section is installed inside the previously installed section and consequently its external diameter has to be less than the internal diameter of the installed section. Furthermore it is necessary that this annular gap between the internal diameter of the installed section and the external diameter of the next section is sufficient to accommodate the connecting means between the two sections which includes hanging and packing means as well as the additional diameter of the joints between each length of tubing making up each section. The annular gaps between each subsequent casing section determine the size of the first casing section which is required to be sufficiently large to enable all the required subsequent casing sections to be passed through it and installed in the well. The final casing section is of sufficient diameter to carry out all the desired functions in the production zone of the well which may require over 5 different lengths of casing sections. This results in the first casing section being very large in diameter and therefore expensive and requiring a large diameter hole to be drilled out in order to accommodate it. Further more it is necessary due to the large diameter of the upper sections to extend the smaller diameter lower sections all the away to the surface in order that the required pressure resistance is provided. The objective of the invention therefore is to reduce this required diameter of the sections to considerably reduce the overall costs of the well both in terms of the drilling itself and disposable of the drilled material and in terms of the costs of the large diameter sections.

It has been proposed previously to provide lower diameter sections by reducing the annular space as much as possible, for example in US-A-

5307886. The problem with such a narrow annulus and with the method of installation disclosed in this patent and used conventionally is that the well fluids displaced by the introduction and lowering of the subsequent casing section into the well have to pass up the annular space to exit the well at the surface. This presents considerable disadvantages due to the very high friction pressure which are required to be overcome in order for the well fluids to pass up the narrow annular space. Consequently even with high hydrostatic pressures the installation time is very slow time due to the time taken for the fluids to pass up the annular space. Additionally the circulation of cement is very problematic because it relies on the displacement of the mud fluids in the well which are difficult to effectively displace all of the mud which causes incomplete cementing.

It is therefore the purpose of the present invention to provide an improved method of installation of a casing in a well and an apparatus therefore.

According to the invention there is provided a method of installing a casing section in a well, wherein the casing section to be installed is lowered into the well by means of an installing tool which is arranged at the end of the tubular lowering means, the installing tool being comprised in first and second tool parts, the first tool part is connected at an upper end of the casing section and the second tool part being connected at the lower end of the casing section.

Preferably first and second flow paths are provided in each of the first and second tool parts to enable fluids from the well to pass through the inside of the casing, as the casing is lowered into the well.

The first and second flow paths may be ports controlled by valves which are held in the in the open position, during the lowering of the casing.

Preferably the first and second tool parts are connected by the tubular lowering means which extends through the first tool part to the second tool part. A hollow is provided through the second tool part connecting the inside of the tubular lowering means to the outside of the casing.

Preferably a lockable non return valve is provided in the hollow which when in the locked open position permits the well fluids to flow from inside the internal bore of the tubular lowering means to the well outside the section being installed, and also permitting fluids to flow from the well to the inside of the tubular lowering means and thus back to surface. When the casing to be fitted has been lowered to its installed position the lockable return valve is unlocked thus operating as a conventional non return valve and preventing the unwanted flow of fluids up the internal bore of the section being installed.

This may be done by pressurising an activating ball which is of such dimensions that it releases a catch device which had been holding the non-return safety valve in the open position.

The casing sealing cement is then pumped down through the internal bore of the lowering means through the lowering tool and down through the internal bore of the casing section being installed, out through the bottom end thereof through the open non-return valve and back up into fill the annular space between the casing section being installed and the drilled well.

The well fluids are displaced upwards through the gap between the casing being installed and the existing casing, into the annular space between the tubular lowering means and the existing casing section.

The preferred embodiments of the invention will now be described with reference to the following drawings in which:

Fig. 1 is a front elevation of a well casing of the prior art,

Fig. 2 is a front elevation of the well casing according to the invention,

Fig. 3 is a cross section through the casing of the invention viewed well in the uppermost section,

Fig. 4 is a longitudinal section of a well comprising the casing according to the invention showing a drilled out portion of the well,

Fig. 5 is a longitudinal section of a well comprising the casing and apparatus according to the invention showing a first step of the method of casing installation the invention,

Fig. 6 is a longitudinal section of the lower end of a casing section of the invention,

Fig. 7 is a longitudinal section of the casing being installed subsequent to the step of fig. 5,

Fig. 8 is the same as fig. 7 showing a further circulation path,

Fig. 9 is the same as fig. 7 showing the casing in the installed position,

Fig. 10 is an enlarged longitudinal section of the lower end of the casing being fitted of fig 7,

Fig. 11 is the same as fig. 10 showing a further circulation path,

Fig. 12 is the same as fig. 10 with the casing in the installed position,

Fig. 13 is the same as fig. 12 with the lower end of the casing sealed off,

Fig. 14 is an enlarged cross section of the upper part of the casing being fitted,

Fig. 15 the same as fig. 14 showing a subsequent step, and

Fig. 16 the same as fig. 15 showing a subsequent step.

Referring to the fig. 1 it can be seen that conventionally a well casing comprises a very wide diameter section at the surface which gradually reduces with each subsequent section as the well progresses downwards. This particular well is shown 4500 meters deep. The uppermost casing section 2 is typically 18.875 inches (47.94 cm) in diameter although in some wells this uppermost casing section is as large as 30 inches (76.2 cm). A second casing section 3 extends inside the uppermost casing section 2 from the surface and is 13.375 inches (33.97 cm) in diameter with an annular gap D1 between it and the internal diameter of the first casing section 2. Subsequently a third casing section 4 of approximately 9.625 inches (24.45 cm) is inserted inside the second casing section 3 and extends from the surface with an annular gap D2 from the second casing section 3. A fourth casing section 5 is then inserted from the surface having a diameter of 7 inches (17.78 cm) with an annular gap D4 from the third casing section. Finally a fifth casing section 6 of 5 inches diameter (12.7 cm) is installed being hung off the previous casing section 5 and leaving an annular gap D4.

In this conventional casing, each casing section is lowered at a sufficient speed to permit a adequately fast construction time for the well because the well fluids can be displaced from the lower parts of the well through the annular gaps D1, D2, D3, D4 to the top of the well as the casing sections are lowered into the well. However the required width of the well has resulted in the use of expensive large diameter casing tubing and also in the removal of considerable amounts of cut rock which has to be disposed of.

Fig. 2 is a casing according to the invention which has a first casing section 12 having a diameter of 6.625 inches (16.83 cm). A second casing 13 is having a diameter of 6 inches (15.24 cm) is installed and hung off the lower end of the first casing section 12 which results in a small annular gap D1. The subsequent sections 14, 15, 16 are 5.375, 4.75 and 4.125 inches in diameter respectively and each is hung-off the

lower end of the previously installed section and cemented in the usual way. This results in a much lower annular gap which also has the consequence that considerably less material has to be drilled out of the well and disposed of and casing sections of considerably lower diameters can be used. This dramatically lowers the cost of the well.

Fig. 3 shows the casing sections 12, 13, 14, 15, 16 according to the invention in cross section and also the small annular gaps between each casing section.

The invention provides a method of installing the casing sections 12, 13, 14, 15, 16 with small annular gaps there between and which permits the casing sections 12, 13, 14, 15, 16 to be installed in a speedy way which does not cause increases in the construction time of the well.

Referring to fig. 4 a well is shown by way of example with casing sections 13 and 14 already installed and cemented in by cement 19. The well hole is further drilled out below the last casing section 14 and to a greater diameter then the last casing section to form a new drilled section 17 in the new rock 18. This over diameter reaming drilling can be carried out using known drilling techniques. It will be appreciated that the invention can be applied to any well which is drilled by any known technique.

Referring to fig. 5 the section 15 to be installed is lowered into the well. The gap between the existing casing 14 and the new casing 15 is exaggerated to show the details more clearly, but in reality this gap would be much smaller than in conventional casing procedures as a consequence of the invention. In the embodiment shown in fig. 5 the casing section 15 and the supporting tube 26 is provided by a length of joined tubing. The casing section 15 and the supporting tube 26 are alternatively and preferably provided by a suitable length of continuous coiled tubing which would be installed into the well from a reel. In the fig. 5 the casing section 15 has already being installed and is held in the position shown

with the upper most part of the casing section 15 just below the top of the well.

The lower end of the casing 15 comprises a lockable non-return valve 36 which normally permits flow downwardly out of the lower end of the casing 15 but prevents flow upwardly into the casing 15 but which my be optionally held in the open position to allow the well fluids to pass up the inside of the casing section 15. The lowering tool 25 comprises gripping seals 94 which grip the casing section 15 as it is lowered into the well. The lowering tool 25 has an internal bore 28 which permits the displaced well fluids to pass up through the lowering tool 25 and out through the coiled tubing 26 to be filtered and re-used or disposed of in the usual way. Similarly fluids may be pumped down the bore 28 of the tubing 26 to carry out the installation procedure which will be described in detail below.

Referring to fig. 5, as the casing section 15 is lowered further into the well the displaced fluids pass up the internal bore of the lowering tool 25, and the annulus between the lowering tool 25 and existing casing 12, 13, 14 through side valves 30 provided in the lowering tool 25. Alternatively positive pressure may be applied to the coiled tubing 26 to ensure that all the displaced fluids are displaced into the main well casing 12 and dealt with by the usual mud handling facilities at the surface of the well. It is easier to dispose of the well fluids if they are displaced through the annulus and also the working platform and the coiled tubing reel is not exposed to the production reservoir which may be subject to uncertain reservoir pressures. These are best dealt with in the conventional way by allowing the well fluids to be displaced through the annulus between the coiled tubing lowering means 26 and the existing casing 12, 13, 14 as the new length of casing 15 is lowered into the well.

Referring now to figs. 7 to 9, a specific embodiment of the lowering method is shown. Firstly referring to fig. 7, the casing section to be fitted 15 is being lowered to its lower required position and is passing through the last existing casing 14 which results in severe restriction to the fluid

flow. The fluid is permitted to flow into the casing being fitted 15 by means of open pathways 61 arranged in the shoe 60 which is fitted to the lower end of the casing being fitted 15. The fluid flows out of the casing being fitted 15 at its upper end through path ways 96 arranged at the upper end of the casing 15. When the lower end of the casing 15 reaches the open hole as shown in fig. 7 it may be necessary to increase the flow rate to assist in the clean up of the hole. Flushing fluid is pumped down the centre of the tubing 26 and passes back up through the pathways 61 and 96 as shown by the arrows in figs. 7 and 12. This pumping may continue as the casing is lowered into the open part of the hole to ensure that the hole is clear of debris and that the debris does not clog up the valves and pathways in the installing tool parts 60, 90.

Additionally or alternatively it may also be desirable and is possible by means of the invention to reverse circulate to assist in the passage of the casing and this is shown in fig. 8. Fluid is pumped down the annulus and circulated up the installing tool tubing 26 back to surface as show by the arrows in fig. 8 and 11. The check valve 97 in the upper lowering tool part 90 only permits flow upwardly from inside the casing 15, so when fluid is pumped down the existing casing it is forced down the annular gap between the casing being fitted 15 and the existing casing and then the flow goes back up the installing tool tubing 26.

By means of one or both of the circulation method of figures 7 and 8 the lower end of the casing being fitted, the installing tool shoe 60, valve 36 and pathways 61 are kept clear of any debris in the drilled hole which may cause blockages.

Referring now to figs. 9 and 13, when the installing tool is at the correct setting depth there is a weight indication at the surface by means of weight sensing means. The circulation is then stopped and the lockable non return valves 36 ar activated by lowering a ball 68 down through the lowering means 25 under pressure. There are many other ways of remotely activating the lockable non return valve which will be apparent to the person skilled in the art.

The tubing 26 is then pressurised up to close all other circulation paths and in particular the path ways 61, and activate the not return valves in the shoe 60. "Bottom up" circulation can now be performed in readiness for the cementing operation. The check valve 97 ensures that there is no flow back into the casing 15. The circulated fluid passes down the tubing 26, and through the remaining annular gap between the existing casing and the casing being fitted 15 across the length of the overlap of the existing casing and the casing being fitted 15. The pressure drop across this overlap is preferably of the order of 300 psi (20 bar), although other pressures may be effective.

Figs. 10 to 13 show the same circulation procedures as described with reference to figs. 7 to 9 and are enlarged views of the lower part to show a more detailed specific embodiment of flow paths and valves. The non return valves 36 are locked open to permit circulation back inside the casing 15 as shown in fig. 10. Fluid is pumped down through the running in tubing 26 out through the exit port 62 in the casing shoe 60 and back in through path ways 61 in the shoe 60 and back into the inside of the casing 15. Reverse circulation is shown in fig. 11 where fluid is pumped down the existing casing and is constrained to flow in the annulus between the casing being fitted and the existing casing and passes up through the exit port 62. The pathways 61 are effectively closed in this set up by the check valves 97, which are closed by the pressure of the fluid in the existing casing, to constrain the fluid up the running in tubing 26.

Referring to fig. 12, when the casing 15 is in position, the non return valves 36 are activated by the ball 68 which is passed through under pressure releasing the non return valves 36 by engaging against a housing 69 arranged in a central channel. The ball 68 has also caused a blocking collar 71 to seal the pathways 61 and 61a, which effectively seals off access to the inside of the casing 15. Detents 72 locate the blocking collar 71 in the closed position. Bottom up circulation can then take place to cement the casing 15 in position. Cement is pumped down through the installing tool tubing 26 and pushes the fluids in front of it downwards out

through the exit port 62 and back up the outside of the casing 15. When the cementing operation is complete a wiper 74 is passed down the lowering tube 26 under pressure to wipe any remaining cement that may have adhered to the inside wall of the tube 26. In this embodiment the wiper 74 also serves as a seal to block and seal the hollow end 62 of the tube 26 for the subsequent pressurising to fix and seal the casing.

It will be appreciated that the sealing operation can be carried out by any suitable convenient means such as a separate sealing member being passed down under pressure or by activation of sealing member already located within the lower tool part 60.

Fig. 6 shows the internal profile of the lower end of the casing in which the casing shoe 60 is located and which also forms the hanging support for the subsequent casing. The shoe has been drilled away to expose the machined internal wall of the casing which is ready for the subsequent casing to be located and secured. The hanging support comprises a series undercuts which form the hanging profile 80 for a subsequent casing. The hanging profile comprises a locating profile 81 which provides surface feedback when the running tool assembly reaches it. Eccentric undercuts 82 to 85 are provided in the profile to provide both tensile and torsion restraint. The profile 80 also includes concentric knife edges 86 to provide a pressure seal.

Referring now to figs. 14 and 15 a more detailed embodiment of an upper part 90 of the installing tool is shown which is arranged at the upper end of the casing 15 being conveyed into the well and provides flow paths 96 for the various circulation modes and also sets and seals the casing 15 once the cementing operation has been completed. The upper part 90 includes a swage expanding mechanism 91 which provides a high pressure seal between the new casing 15 and the existing casing when the cementing process has been completed. The upper part 90 of the installing tool also comprises dimple formers 92 which correspond with the eccentric undercuts of the hanger profile of the existing casing to mechanically locate and fix the casing bei:· installed in the required

position on the existing casing. A simple locating means 93 is provided which co-operates with the corresponding locating profile 81 in the existing casing to accurately locate the upper tool part 90 in the existing casing.

The mechanical dimpled formers 92 and the pressure seal 91 are activated by means of internal pressure applied by means of pressurised fluid introduced in the lower tubing means 26.

Fig. 16 shows the casing 15 located and sealed in its desired position and the running tool 25 has been released and retrieved to surface by means of the running-in tubing 26.

The section being fitted could also be a sand screen as well as a casing section such sand screen being necessary to protect the well from areas of formation which generate sand as well as the desired hydrocarbons.

The section being fitted could also be a mono-bore liner or completion barrier. Such a completion barrier will be installed when all the casing section required are installed and the drilling of the well is complete.

In the embodiments described above the well hole has been pre-drilled to the depth of a pre-determined length of casing and the casing is subsequently lowered into the pre-drilled hole. In a further embodiment of the invention shown in figures 17 to 21 the shoe 60 is replaced by a drill bit arrangement 160 arranged at the lower end of the casing. The drill could be either an electrically powered drill of a pressurised fluid drill. The rotating drill removes material from the lower end of the well and this material is cleared away by pressurised fluid (usually drilling mud) passing down through the bore 28 of the lowering tube 126 and out through passages 161 in the drill head and back into the annular space between the tube 26 and the casing 15 via ports 162 at the lower end of the casing.

Percussion impact means 166 are provided along the tubular lowering means which provide additional downwards force to the drill and are supported by the casing being lowered and permit fluid to flow through the annulus. The percussion impact means 166 are preferably driven by fluid pumped into the tube 126.

Referring to figs. 19 to 21 a more detailed embodiment of a drill arrangement is shown. In fig. 19 the drill arrangement 160 is provided on the end of a lowering tube 126 and is lowered inside the casing to be installed 115 spring biased securing means 163 are provided which are activated to extend into corresponding locating openings 165 in the casing. The securing means 163 may be so arranged to automatically engage in the locating means 165 when the correct position is reached. When the drill arrangement 160 is in the desired position at the lower end of the casing drilling elements 164 are extended so that the desired diameter of hole (being necessarily larger than the casing), can be achieved. Engaging means 166 are provided which when activated will urge the drilling elements 164 into the extended position.

In this way the casing is installed in the same operation as the hole is formed which provides considerable reductions in the time to create the well as a whole. In order to complete the cementing operation the drilling arrangement 160 may be removed from the end of the casing and retrieved back to surface on the end of the lowering tube 126 and the shoe arrangement as described in relation to figs 10 to 13 can be fitted and lowered into the casing to carry out the cementing and securing operation. Alternatively the drilling arrangement could be adapted to carry out the cementing operation after the desired length of hole has been drilled.

Referring now to fig. 3 in conjunction with above description a well casing can be constructed with the minimum of annular gap between each length of casing. For example a well casing comprising a number of casing lengths 12, 13, 14, 15, 16 with a first casing section 12 having and outside diameter OD12 of 6.625 inches and an inside diameter ID12 of 6.125 inches being fitted and cemented in position extending downwardly

from the top of the well. The second casing section 13 has an outside diameter OD13 of 6 inches and an inside diameter ID13 5.5 inches. The difference D1 between the outside diameter OD13 of the section 13 is less that the internal diameter ID12 of the first section 12 being an amount which is just sufficient for the second to pass down through the internal bore of the first section 12. This difference is 0.25 inches (0.635 cm) in the present exemplary embodiment. However it will be appreciated that the invention can be applied to any annular gap size which is required to accommodate the variances in the ovality and other dimensions in the casing sections of the well. It has been found that differences D1, D2, D3, D4, D5 may be as high as 15 mm and a low as 0.1 mm. The actual difference will be as low as possible to maintain the dimensions of the well as a whole as slim as possible.

Each subsequent casing section 14, 15, 16 has an internal diameter ID14 of 5.25 inches, ID15 of 4.625 inches and ID16 of 3.5 inches respectively and an external diameter OD14 of 5.375 inches, OD15 of 4.75 inches and OD16 of 4.125 inches respectively. The differences D2, D3, D4 between the external diameters OD14, OD15, OD16 of each subsequent section 14, 15, 16 and the internal diameters ID13, ID14, ID15 of the previously fitted sections 13, 14, 15 will be just sufficient for the subsequent sections 14, 15, 16 to pass through the internal bores of the previously fitted sections 13, 14, 15.

These differences D1, D2, D3, D4 define the annular gap between respective casing sections 12, 13, 14, 15, 16 and according to the invention need not been so large as to permit the flow of fluids there through during the installation of the sections but need only be large enough to allow the sections to pass freely through each other allowing only for the variations of ovality and wall thicknesses according to the tolerances of manufacture of the sections. When planning and designing the well it is necessary to start with the dimensions of the last casing section since this has to be of a certain minimum size to permit the normal operations to take place at the lowermost point of the well. The required sizes of the other sections are calculated upwardly therefrom and will

depend on the expected condition of the rock and location of reservoirs etc. The size of the first section will therefore be eventually calculated and for very deep or long wells will have to have a very large diameter. It is beneficial to reduce this diameter as much as possible. According to the invention this is possible by reducing the annular spaces D1, D2, D3, D4 between the sections to a minimum.

Thus the differences D1, D2, D3, D4 will determine the ultimate required size of the first section.

These differences D1, D2, D3, D4 between the internal diameters ID12, ID13, ID14, ID15 of the fitted sections 12, 13,14, 15 and the outside diameters OD13, OD14, OD15, OD16 of the sections to be fitted 13, 14, 15, 16 may be defined as W (inches or mm) such that the outside diameter ID12 of the first section 12 can be as small as possible and is at most equivalent to:

$$OD12 = W \times (n-1) + 2 \times T \times n + ID16,$$

where T is the average wall thickness of the casing sections 13, 14, 15, 16, ID16 is the internal diameter of the last section and n is the number of casing sections and W is the average diametrical difference.

It has been found that when the casing is made of continuous coiled tubing and my means of the method of the present invention, then W may be less than 15 mm and greater than 0.1 mm depending on the quality of manufacture and length of the section of casing concerned.

It is also preferable and possible in certain circumstances when the well casing is made of continuous coiled tubing that W is less than 10 mm and greater than 0.1 mm. It has also be found that when the well casing is made of continuous coiled tubing and of good quality manufacture with fine tolerance limits on ovality and straightness along its length and if the length of tubing is less than approximately 2000 metres then W may be less than 5 mm and greater than 0.1 mm.

When the well casing is made of joined tubing an additional factor has to be considered and that is the width of the joints between each section. Clearly this will put the greatest limit on the amount to which the value W can be reduced. However it has been determined by the inventor that W may be less than 25 mm and greater than 1 mm and even at the higher end of this range vary useful reductions in the overall diameter of the well and the consequent reductions in material costs and disposal costs as well as well construction time costs can be achieved.

Preferably and also possible by means of the invention is that when the well casing is made of joined tubing W is less than 15 mm and greater than 1 mm.

It has also been found to be possible for certain types of wells depending on the operating demands of the well notably pressure that certain special slimmer joints can be used such that the well casing is made of joined tubing with the value W less than 10 mm and greater than 1 mm by means of the invention.

It will be noted that only the apparatus essential to the understanding of the invention itself is shown and described. The use of other equipment and procedures which are known in the art will be necessary and recommended for example, depending on the conditions of the well and its location.

CLAIMS

1. A method of installing a casing section in a well, wherein the casing section to be installed is lowered into the well by means of first and second connection means arranged on a tubular lowering means, the first connection means being connected at an upper end of the casing section and the second connection means being connected at a lower end of the casing section, the tubular lowering means extending through the casing section.

2. A method according to claim 1, characterised in that first and second flow paths are provided correspondingly in the first and second connection means to enable fluid from the well to pass through the inside of the casing in the direction of the top of the hole, as the casing is lowered into the well.

3. A method according to claim 2, characterised in that the first and second flow paths are ports controlled by valves which are held in the open position, during the lowering of the casing.

4. A method according to claim 1, characterised in that at least one opening is provided through the second tool part connecting the inside of the tubular lowering means to the outside of the casing.

5. A method according to claim 4, characterised in that a non return valve is provided in the opening which permits pressurised fluids to flow from inside the internal bore of the tubular lowering means to the well outside the section being installed.

6. A method according to claim 5, characterised in that the non return valve is a lockable non return valve which when in the locked open position permits fluids to flow from the well to the inside of the tubular lowering means and thus back to surface.

7. A method according to claim 6, characterised in that when the casing to be fitted has been lowered to its installed position the lockable return valve is unlocked thus operating as a conventional non return valve and preventing the unwanted flow of fluids up the internal bore of the tubular lowering means.

8. A method according to claim 7, characterised in that an activating ball which is of such dimensions that it releases a catch which had been holding the non-return safety valve in the open position.

9. A method according to claim 8, characterised in that casing sealing cement is then pumped down through the internal bore of the lowering means through the internal bore of the casing section being installed, out through the bottom end thereof through the open non-return valve and back up into fill the annular space between the casing section being installed and the drilled well.

10. A method according to claim 9, characterised in that the well fluids are displaced upwards through the gap between the casing being installed and the existing casing, into the annular space between the tubular lowering means and the existing casing section.

11. A method according to any one of the preceding claims, characterised in that when the casing being installed is in position a pressure seal is provided between the casing being installed and the existing casing.

12. A method according to any preceding claim, characterised in that drilling means are provided to the casing being installed to the hole to be simultaneously or drilled or partly drilled whilst the casing is being lowered into the well.

13. A method according to claim 13, characterised in that percussion impact means are provided along the tubular lowering means which provide additional downwards force to the drill and are supported

by the casing being lowered and permit fluid to flow through the annulus.

14. A method of installing a casing section in a well, wherein the casing section to be installed is lowered into the well by means of a tubular lowering means, characterised in that flow control means are provided to permit flow of fluid either, from a tubular bore of a tube arranged within the casing into the open hole and to permit flow back up the annular space between the tubular lowering means and the casing or from the said annulus into the open hole and back up the tubular bore.

15. An apparatus for carrying out the method of any of the preceding claims.

Amendm[illegible]s to the claims have been filed [illegible] follows

CLAIMS

1. A method of installing a casing section in a well, wherein the casing section to be installed is lowered into the well by means of first and second connection means arranged on a tubular lowering means, the first connection means being connected at an upper end of the casing section and the second connection means being connected at a lower end of the casing section, the tubular lowering means extending through the casing section, characterised in that a flow path is provided through the inside of the casing.

2. A method according to claim 1, characterised in that first and second flow paths are provided correspondingly in the first and second connection means to enable fluid from the well to pass through the inside of the casing in the direction of the top of the hole, as the casing is lowered into the well.

3. A method according to claim 2, characterised in that the first and second flow paths are ports controlled by valves which are held in the open position, during the lowering of the casing.

4. A method according to claim 1, characterised in that at least one opening is provided through the second connection means which provides a flow path from the inside of the tubular lowering means to the outside of the casing.

5. A method according to claim 4, characterised in that a non return valve is provided in the opening which permits pressurised fluids to flow from inside the internal bore of the tubular lowering means to the well outside the section being installed.

6. A method according to claim 5, characterised in that the non return valve is a lockable non return valve which when in the locked open position permits fluids to flow from the well to the inside of the tubular lowering means and thus back to surface.

by the casing being lowered and permit fluid to flow through the annulus.

14. A method of installing a casing section in a well according to claim 1, wherein the casing section to be installed is lowered into the well by means of a tubular lowering means, characterised in that flow control means are provided to permit flow of fluid either, from a tubular bore of a tube arranged within the casing into the open hole and to permit flow back up the annular space between the tubular lowering means and the casing or from the said annulus into the open hole and back up the tubular bore.

15. An apparatus according to any preceding claim for carrying out the method claimed therein.

The Patent Office

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Application No:	GB 9912369.7	**Examiner:**	David McWilliams
Claims searched:	1-13, 15	**Date of search:**	14 July 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): E1F: FAC, FCJ, FCM, FJR

Int Cl (Ed.6): E21B

Other: ON-LINE: EPODOC

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB2311314A	HEAD (see whole document)	-
X	EP0241354A	AQUITAINE (see whole document)	1,12
X	WO94/12760A	JARVELA (see whole document)	1,12,13
X	WO91/10805A	STJERNSTROM (see whole document)	1,12,13
X	WO90/00216A	KVELLO-AUNE (see whole document)	1,12

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